after coronary artery bypass grafting. *Ann Thorac Surg*. 1999;67:1045-52.
3. Carson JL, Scholz PM, Chen AY, Petersen ED, Gold J, Schneider SH. Diabetes mellitus increases short-term mortality and morbidity in patients undergoing coronary artery bypass graft surgery. *J Am Coll Cardiol*. 2002;40:418-23.
4. Woods SE, Smith JM, Sohail S, Sarah A, Engle A. The influence of type 2 diabetes mellitus in patients undergoing coronary artery bypass graft surgery. *Chest*. 2004;126:1789-95.
5. Rajakaruna C, Rogers CA, Suranimala C, Angelini GD, Ascione R. The effect of diabetes mellitus on patients undergoing coronary surgery: a risk adjusted analysis. *J Thorac Cardiovasc Surg*. 2006;132:802-10.
6. Calafiore AM, Di Mauro M, Di Giammarco G, Contini M, Vitolla G, Iaco AL, et al. Effect of diabetes on early and late survival after isolated first coronary bypass surgery in multivessel disease. *J Thorac Cardiovasc Surg*. 2003;125:144-54.
7. Kubal C, Srinivasan AK, Grayson AD, Fabri BM, Chalmers JAC. Effect of risk-adjusted diabetes on mortality and morbidity after coronary artery bypass surgery. *Ann Thorac Surg*. 2005;79:1570-6.
8. Whang W, Bigger JT. Diabetes and outcomes of coronary artery bypass graft surgery in patients with severe left ventricular dysfunction: results from the CABG Patch Trial Database. *J Am Coll Cardiol*. 2000;36:1166-72.
9. Szabo Z, Hakanson E, Svedjeholm R. Early postoperative outcome and medium-term survival in 540 diabetic and 2239 nondiabetic patients undergoing coronary artery bypass grafting. *Ann Thorac Surg*. 2002;74:712-9.
10. Furnary AP, Wu Y. Eliminating the diabetic disadvantage: the Portland diabetic project. *Semin Thorac Cardiovasc Surg*. 2006;18:302-8.
11. Lazar HL, Chipkin SR, Fitzgerald CA, Bao Y, Cabral H, Apstein CS. Tight glycemic control in diabetic coronary artery bypass graft patients improves perioperative outcomes and decreases recurrent ischemic events. *Circulation*. 2004;109:1497-502.
12. Carr JM, Sellke FW, Fey M, Doyle MJ, Krempin JA, de la Torre R, et al. Implementing tight glucose control after coronary artery bypass surgery. *Ann Thorac Surg*. 2005;80:902-9.
13. Lazar HL, Chipkin S, Philippides G, Bao Y, Apstein C. Glucose-insulin-potassium solutions improve outcomes in diabetics who have coronary artery operations. *Ann Thorac Surg*. 2000;70:145-50.
14. Furnary AP, Gao G, Grunkemeier GL, Wu Y, Zerr KJ, Bookin SO, et al. Continuous insulin infusion reduces mortality in patients with diabetes undergoing coronary artery bypass grafting. *J Thorac Cardiovasc Surg*. 2003;125:1007-21.
15. Furnary AP, Zerr KJ, Grunkemeier GL, Starr A. Continuous intravenous insulin infusion reduces the incidence of deep sternal wound infection in diabetic patients after cardiac surgical procedures. *Ann Thorac Surg*. 1999;67:352-62.
16. American Diabetes Association. Standards of medical care in diabetes. *Diabetes Care*. 2005;28:S4-36.
17. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med*. 1993;329:977-86.
18. UK Prospective Diabetes Study (UKPDS) group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet*. 1998;352:837-53.
19. Rubin DB. Inference and missing data. *Biometrika*. 1976;53:581-92.
20. The Bypass Angioplasty Revascularization Investigation (BARI) Investigators. Influence of diabetes on 5-year mortality and morbidity in a randomized trial comparing CABG and PTCA in patients with multivessel disease. *Circulation*. 1997;96:1761-9.
21. Leavitt BJ, Sheppard L, Maloney C, Clough RA, Braxton JH, Charlesworth DC, et al. Effect of diabetes and associated conditions on long-term survival after coronary artery bypass graft surgery. *Circulation*. 2004;110:41-4.
22. Hirotani T, Kameda T, Kumamoto T, Shirota S, Yamano M. Effects of coronary artery bypass grafting using internal mammary arteries for diabetic patients. *J Am Coll Cardiol*. 1999;34:532-8.
23. Bradshaw PJ, Jamrozik K, Gilfillan I, Thompson PL. Preventing recurrent events long term after coronary artery bypass graft: suboptimal use of medications in a population study. *Am Heart J*. 2004;147:1047-53.
24. Lawrie GM, Morris GC Jr, Glaeser DH. Influence of diabetes mellitus on the results of coronary bypass surgery: follow-up of 212 diabetic patients ten to fifteen years after surgery. *JAMA*. 1986;256:2967-71.
25. Herlitz J, Wognsen GB, Emanuelsson H, Haglid M, Karlson BW, Karlsson T, et al. Mortality and morbidity in diabetic and nondiabetic patients during a 2-year period after coronary artery bypass grafting. *Diabetes Care*. 1996;30:71-5.
26. Salomon NW, Page US, Okies JE, Stephens J, Krause AH, Bigelow JC. Diabetes mellitus and coronary artery bypass: short-term risk and long-term prognosis. *J Thorac Cardiovasc Surg*. 1983;85:264-71.
27. Clement R, Rousou JA, Engelman RM, Breyer RH. Perioperative morbidity in diabetics requiring coronary artery bypass surgery. *Ann Thorac Surg*. 1988;46:321-3.
28. Fietsam R Jr, Bassett J, Glover JL. Complications of coronary artery surgery in diabetic patients. *Am Surg*. 1991;57:551-7.
29. Saudek CD, Derr RL, Kalyani RR. Assessing glycemia in diabetes using self-monitoring blood glucose and hemoglobin A1c. *JAMA*. 2006;295:1688-97.
30. The ACE/ADA Task Force on Inpatient Diabetes. American College of Endocrinology and American Diabetes Association Consensus Statement on inpatient diabetes and glycemic control. *Diabetes Care*. 2006;29:1955-62.

Discussion

Dr Harold L. Lazar *(Boston, Mass)*. In their study, Dr Halkos and colleagues found that an elevated preoperative HbA1c level was associated with a significant increase in mortality and morbidity. This is not surprising because patients with an elevated HbA1c had a higher incidence of preoperative renal failure, strokes, peripheral vascular disease, and diffuse coronary artery disease, which required more grafts. All of these factors are independently known to be predictive of adverse outcomes after bypass surgery.

My first question is whether an elevated HbA1c is a marker of advanced diabetic end-organ disease or does it really represent poor intraoperative glycemic control? Did you actually measure the perioperative glucose values between the high and low HbA1c groups to see whether or not your protocols actually achieved tight glycemic control in the elevated HbA1c group, and did the patients with elevated HbA1c levels who had lower perioperative glucose values have decreased morbidity and mortality?

Dr Halkos. Let me first start by addressing the question regarding tight intraoperative glycemic control. We did not collect those data because they were not accessible to us regarding the blood glucose levels in the operating room and intensive care unit setting. However, all of our patients undergoing primary elective CABG are maintained in the same fashion with regard to the regimen in which their blood glucose is controlled both in the operating room and in the intensive care unit, as well as how they are transitioned on the floor.

Dr Lazar. I think that may be important data because we have found that it is more difficult to achieve tighter glycemic control in patients with elevated HbA1c even though there is a set protocol. I may actually answer your first clinical implication as to whether or not these patients can be delayed. Perhaps these patients may have to have more vigorous intraoperative control of their glucose levels.

My second question is, were the adverse effects of an elevated HbA1c related to the type of diabetes? In other words, did insulin-dependent diabetic patients have worse outcomes compared with patients treated with oral agents or diet alone?

Dr Halkos. Let me answer that with regard to a previous question that you asked regarding patients with elevated HbA1c: Are the intraoperative and perioperative glucose levels or the comorbidities associated with poorly controlled diabetes? We believe that it may very well be the comorbidities associated with poorly controlled diabetes, which is reflected by an elevated HbA1c. With regard to the last question, rephrase that last part for me.

Dr Lazar. Did insulin diabetic patients have worse outcomes than those with oral agents or diet alone?

Dr Halkos. We did not look into the subgroupings of how diabetes was controlled in patients with regard to their method of control. In our study, approximately 20% of patients were receiving insulin therapy, and then 50% were receiving oral hypoglycemic medications or a combination thereof. So part of the reason for not looking at the data in that fashion was the combination thereof was not well defined in our database.

Dr Lazar. Patients in the elevated HbA1c group had significantly higher mortality. What were the differences in the cause of death between the groups? Were the patients with elevated HbA1c more likely to die of cardiac causes or was it more related to their increased incidence of renal fairly, strokes, and peripheral vascular disease?

Dr Halkos. With regard to the cause of death, we really didn't look into the cause with regard to their cause of mortality other than report the associated morbidities.

Dr Lazar. In your study, 70% of patients underwent off-pump surgery, yet patients with an elevated HbA1c were more likely to undergo on-pump surgery. What was the crossover rate from the off-pump to the on-pump groups in this study, and were the patients with an elevated HbA1c who crossed over more likely to have an adverse outcome? I must say these data were derived from the article, which you were kind enough to send to me in advance.

Dr Halkos. Yes, sir. I don't know the exact crossover rate, but I know that during the period of the study it was very low, with a 2% crossover. Patients were categorized according to whether they underwent on- or off-pump surgery according to the ultimate procedure that was used. So that is a piece of data that can be misleading. We believe that even though slightly more patients underwent on-pump surgery in the higher A1c subgroup, that was only approximately 4% to 5% higher than the A1c group (<7%).

Dr Lazar. Recent studies have shown that patients receiving angiotensin-converting enzyme inhibitors, beta-blockers, and statins in the perioperative period have decreased morbidity and mortality. Can you tell us what percentage of patients in the study received these medications and was there a difference in the use of these medications between the HbA1c groups?

Dr Halkos. Again, almost all of our patients are managed in the same way: They receive aspirin preoperatively, angiotensin-converting enzyme inhibitors are discontinued preoperatively in almost all patients, and they receive beta-blocker therapy.

Dr Lazar. One final question, again from the article. Your data implied that elevated HbA1c levels were actually protective from developing atrial fibrillation. In other words, people with elevated HbA1c actually had a lower incidence of atrial fibrillation. Can you explain that and give us an idea of what the mechanism was?

Dr Halkos. We reported all of these outcomes, and in this study, which was not presented in the slides, there was a 30% lower incidence of atrial fibrillation in patients with an elevated A1c, but this was statistically significant, and we do not have a mechanism to explain why that difference existed.